

Perspective-Aware Road Obstacle Detection

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Abstract. While road obstacle detection techniques have become increasingly effective, they typically ignore the fact that, in practice, the apparent size of the obstacles decreases as their distance to the vehicle increases. In this paper, we account for this by computing a scale map encoding the apparent size of a hypothetical object at every image location. We then leverage this perspective map to (i) generate training data by injecting synthetic objects onto the road in a scene-specific fashion (thus avoiding overfitting) and (ii) incorporate perspective information in the decoding part of the detection network to guide the obstacle detection. Our results are standard benchmarks show that, together, these two strategies significantly boost the obstacle detection performance, allowing our approach to consistently outperform state-of-the-art methods in terms of instance-level obstacle detection.

1. Introduction

Vehicle-based driving assistance is more commercially available [3] and enables vehicles to plan a path within the predicted obstacle space while avoiding other traffic. However, missed and unexpected obstacles lying on the road remain a potential danger. Since not every vehicle has access to a LiDAR sensor to detect them in 3D, much effort has recently been made to achieve detection in a monocular fashion via learning-based strategies. Such road obstacle detection can also be beneficial for vehicles in rural environments. Given that such objects are under-represented obtaining sufficient datasets of real images associated with such obstacles for training purposes is impractical. Hence, many state-of-the-art deep learning approaches [24, 17, 34, 17] rely on synthetically generated training data, for example by creating real objects and inserting them into rendered scenes of the Cityscapes dataset.

However, these methods fail to leverage the vehicle generating training data and performing the actual detection, the predictable perspective knowledge in images captured by cameras’ monocular cameras. It is a standard practice [34–36, 17] to insert objects of arbitrary sizes at any image location in the training data used to detect objects at multiple scales irrespective of where they appear in the image. This does not exploit the well-known fact that more distant objects tend to be smaller and thus, given a calibrated camera, the relationship between real and perceived sizes in images.

In this work, we show that leveraging the perspective information substantially improves performance. To this end, as shown in Fig. 1, we compute a scale map, where pixel values denote the apparent size of pixels of a hypothetical meter-wide object placed at that point on the road. We then exploit this information in two straightforward steps:

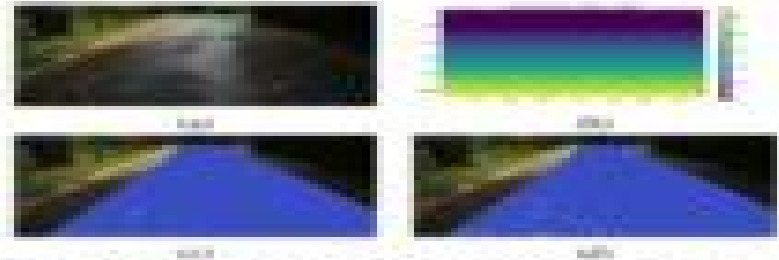


Fig. 1: **Size and distance in close and landmark, car (green) images.** The perspective map encodes the size and distance of the objects in the scene, and the red color indicates objects far from the camera. (a) The perspective map is computed, as each pixel, the size is given of a hypothetical meter-wide object at that location. (b) Our approach uses the perspective map to distinguish relevant objects from irrelevant ones. It correctly flags as relevant pixels of the real obstacle while ignoring the background. (c) Without the perspective aware encoder, we are confused with a similar background flag (blue) (d).

- 1. **Perspective-Aware Synthetic Object Injection.** Instead of uniformly injecting synthetic objects into road scenes to synthesized training data, as in [34, 36, 17] we use the perspective map to appropriately set the projected size of the objects in scene.
- 2. **Perspective-Aware Architecture.** We feed the perspective map at multiple levels of a feature pyramid network, enabling it to learn the relation inferring between distance and size embedded in our training set and in real road scenes.

The bottom portion of Fig. 1 illustrates the benefits of our approach. It not only detects small far-away obstacles but also avoids false alarms arising from small irregularities near the road, such as the fence fence. Because there are at this image location there are much less of real objects in the image. Our results show that these strategies together contribute to significantly improving the accuracy of road obstacle detection, particularly in terms of instance-level detection, which is critical for a self-driving car that need to identify all potential hazards on the road.

We evaluate our approach on the Argoverse 1B [8] and Cam [9] benchmarks’s obstacle task and the Lyft/Pose2 [6] test subset. We demonstrate that it significantly outperforms most of the state-of-the-art via ablation studies similar to ours, but without explicit perspective handling. The code of our method and the results publicly available.

Obstacle Detection Answer Keys

Lingjun Ying



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Advanced Intelligent Computing Technology and Applications De-Shuang Huang, Qinhu Zhang, Chuanlei Zhang, Wei Chen, 2025-07-17 The 12 volume set CCIS 2564 2575 together with the 28 volume set LNCS LNAI LNBI 15842 15869 constitutes the refereed proceedings of the 21st International Conference on Intelligent Computing ICIC 2025 held in Ningbo China during July 26 29 2025 The 523 papers presented in these proceedings books were carefully reviewed and selected from 4032 submissions This year the conference concentrated mainly on the theories and methodologies as well as the emerging applications of intelligent computing Its aim was to unify the picture of contemporary intelligent computing techniques as an integral concept that highlights the trends in advanced computational intelligence and bridges theoretical research with applications Therefore the theme for this conference was Advanced Intelligent Computing Technology and Applications

Handbook of Deep Learning Applications Valentina Emilia Balas, Sanjiban Sekhar Roy, Dharmendra Sharma, Pijush Samui, 2019-02-25 This book presents a broad range of deep learning applications related to vision natural language processing gene expression arbitrary object recognition driverless cars semantic image segmentation deep visual residual abstraction brain computer interfaces big data processing hierarchical deep learning networks as game playing artefacts using regret matching and building GPU accelerated deep learning frameworks Deep learning an advanced level of machine learning technique that combines class of learning algorithms with the use of many layers of nonlinear units has gained considerable attention in recent times Unlike other books on the market this volume addresses the challenges of deep learning implementation computation time and the complexity of reasoning and modeling different type of data As such it is a valuable and comprehensive resource for engineers researchers graduate students and Ph D scholars

Self Driving Cars Demystified StoryBuddiesPlay, 2024-10-28 This chapter delves into the intricate world of path planning for autonomous vehicles highlighting the critical algorithms and techniques that enable self driving cars to navigate safely and efficiently Covering everything from global and local planning to behavioral decision making it addresses the challenges posed by dynamic environments and complex scenarios like intersections and merging As technology evolves we explore how machine learning and real time data enhance path planning capabilities ensuring that autonomous vehicles can adapt to changing conditions while prioritizing safety and passenger comfort Whether you re a developer engineer or enthusiast this chapter provides valuable insights into the future of autonomous navigation path planning autonomous vehicles self driving cars obstacle avoidance motion planning behavioral planning navigation algorithms traffic rules machine learning dynamic environments

Automatic Control, Mechatronics and Industrial Engineering Yigang He, Xue Qing, 2019-03-20 Engineering technology development and implementation play an important role in making the industry more sustainable in

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Department of Transportation and Related Agencies Appropriations for Fiscal Year 1998 United States.

Congress. Senate. Committee on Appropriations. Subcommittee on Transportation and Related Agencies,1998 *Automated Driving and Driver Assistance Systems* Tom Denton,Haley Pells,Grahame Pells,2025-08-28 Automated vehicles are poised to revolutionise transportation yet Advanced Driver Assistance Systems ADAS represent the cutting edge technology of today Written in accessible language Automated Driving and Driver Assistance Systems breaks down complex concepts to highlight the integration of existing systems in modern vehicles Written in line with the UK s Autonomous Vehicles Act 2024 this heavily revised new edition offers practical insights and case studies for an international audience This book is essential for automotive students at both further education and undergraduate levels as well as for practising technicians and professionals in the automotive industry

IoT Security SK Hafizul Islam,Debabrata Samanta,Arup Kumar Pal,Ummar Iqbal,2025-10-15 IoT Security Fundamentals and Key Enabling Technologies explores the complex interactions between Internet of Things IoT and the pressing need for effective cyber security solutions Diving into real world case studies to provide insights into implementing efficient security measures that safeguard against online dangers this book comprehensively analyzes the challenges and possibilities presented by intelligent technologies fueling transformational change emphasizing the crucial role cybersecurity plays in defending networks data and user privacy in an increasingly interconnected digital ecosystem Coverage includes cryptographic methods communication networks device identity and access data governance and privacy as well as regulatory frameworks and standards for IoT security Computer science researchers and engineers will benefit from this compilation of cutting edge research and practical case studies learning how

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of Things **Assistive Technology Solutions for Aging Adults and Individuals With Disabilities** Pandey, Rajiv, Maurya, Pratibha, Prajapati, Jigna Bhupendra, Halder, Raju, Tyagi, Kanishka, 2025-01-15 Assistive technology solutions enhance the quality of life for aging adults and individuals with disabilities. These innovative tools and devices support daily activities, improve independence, and promote social engagement. From mobility aids like walkers and wheelchairs to advanced communication devices and smart home technologies, assistive technologies cater to a wide range of needs. Continued research into this technology may help create more inclusive environments, ensuring aging adults and those with disabilities can participate in their communities. *Assistive Technology Solutions for Aging Adults and Individuals With Disabilities* addresses the challenges faced by adults and individuals with disabilities through exploration of effective assistive tools. Various devices and technologies are examined, including their usefulness in creating a more inclusive community for those with disabilities and specialized healthcare needs. This book covers topics such as communication devices, mobility aids, and visual assistance and is a useful resource for psychologists, sociologists, healthcare professionals, computer engineers, academicians, and researchers. *Innovations in Smart Cities Applications Volume 5* Mohamed Ben Ahmed, Anouar Abdelhakim Boudhir, İsmail Rakıp Karas, Vipul Jain, Sehl Mellouli, 2022-03-03 This book sets the innovative research contributions, works, and solutions for almost all the intelligent and smart applications in the smart cities. The smart city concept is a relevant topic for industrial governments and citizens. Due to this, the smart city is considered as a multi-domain context that attracts tremendously academics, researchers, and practitioners who provide efforts in theoretical proofs, approaches, architectures, and in applied researches. The importance of smart cities comes essentially from the significant growth of populations in the near future, which conducts to a real need of smart applications that can support this evolution in the future cities. The main scope of this book covers new and original ideas for the next generations of cities using the new technologies. The book involves the application of the data science and AI, IoT technologies, and architectures, smart earth, and water management, smart education, and E-learning systems, smart modeling systems, smart mobility, and renewable energy. It also reports recent research works on big data technologies, image processing, and recognition systems, and smart security and privacy. *Proceedings*, 1993 *Key Methods in Geography* Nicholas Clifford, Meghan Cope, Thomas Gillespie, Shaun French, 2016-05-21 Practical, accessible, careful, and interesting, this revised volume brings the subject up to date and explains in bite-sized chunks the hows and whys of modern-day geographical study. It brings together physical and human approaches again in a new synthesis. Danny Dorling, Professor of Geography, University of Oxford. *Key Methods in Geography* is the perfect introductory companion, providing an overview of qualitative and quantitative methods for human and physical geography. This Third Edition features 12 new chapters representing emerging themes, including online, virtual, and digital geographical methods, real-life case study examples, summaries, and exercises for each chapter. Free online access to full text of *Progress in Human Geography* and *Progress in Physical Geography*. *Progress Reports*. The teaching of research methods is

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Interplay of Artificial General Intelligence with Quantum Computing C. Kishor Kumar Reddy, Shenson Joseph, Herat Joshi, Mariya Ouaisa, Marlia Mohd Hanafiah, 2025-08-12 This book investigates the dynamic relationship between artificial general intelligence AGI and quantum computing AGI refers to a form of AI capable of performing any intellectual task that a human can while quantum computing utilizes quantum mechanics principles to process information in fundamentally different ways compared to classical computing This interplay explores how quantum computing might enhance AGI by accelerating complex computations and optimizing learning algorithms potentially enabling AGI systems to solve problems beyond the reach of traditional computers It also examines the challenges and opportunities presented by combining these technologies including theoretical implications and practical applications in advancing AI capabilities This book examines the groundbreaking intersection of artificial general intelligence AGI and quantum computing The book explores how AGI which aims to replicate human like cognitive abilities can be enhanced by quantum computing s unique processing capabilities It delves into theoretical foundations practical applications and potential synergies illustrating how quantum computing could tackle complex computational challenges inherent in AGI development By integrating these advanced technologies the book provides a comprehensive analysis of their combined impact offering insights into future advancements and the transformative potential of merging AGI with quantum computing

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